


|  |   |
|--|---|
|  <b>MOTION IMAGERY<br/>STANDARDS BOARD</b><br><br><b>STANDARD</b><br><br><b>Timestamps for Class 1/Class 2 Motion Imagery</b> | <b>MISB ST 0604.5</b><br><br><br><br><br><br><br><br><br><br><b>27 October 2016</b> |
|--|---|

## 1 Scope

The MISB mandates that a Precision Time Stamp be inserted into all Class 0/1/2 Motion Imagery. This standard provides guidance and specifies requirements for inserting a Precision Time Stamp into Class 1 and Class 2 Motion Imagery (compressed imagery). In support of the Precision Time Stamp, a Precision Time Stamp Identifier, and a Precision Time Stamp Status value are required as well.

Compression standards, approved by the MISB under Class1/Class 2 Motion Imagery, provide user-defined data fields. This standard specifies the format, encoding and mapping of a Precision Time Stamp Identifier, the Precision Time Stamp Status and the Precision Time Stamp to these user-defined data fields.

This standard also provides guidance for inserting an optional Commercial Time Stamp in reserved fields of each identified compression standard.

## 2 References

- [1] MISB ST 0603.4 MISB Time System and Timestamps, Feb 2016.
- [2] SMPTE EG 40:2016 Conversion of Time Values between SMPTE 12-1 Time Code, MPEG-2 PCR Time Base and Absolute Time, 2016.
- [3] MISB ST 0605.6 Encoding and Inserting Time Stamps and KLV Metadata in Class 0 Motion Imagery, Jun 2015.
- [4] ISO/IEC 13818-2:2013 Information Technology - Generic coding of moving pictures and associated audio information: Video.
- [5] ISO/IEC 14496-10:2014 Information Technology - Coding of audio-visual objects - Part 10: Advanced Video Coding.
- [6] ISO/IEC 23008-2:2015 Information Technology - High efficiency coding and media delivery in heterogeneous environments - Part 2: High efficiency video coding.

### 3 Revision History

| Revision | Date       | Summary of Changes   |
|----------|------------|--|
| 0604.5   | 10/27/2016 | <ul style="list-style-type: none"> <li>• Deprecated REQs -01, -05, -08; Added REQs -16, -17, -18, -19</li> <li>• Revised language to be general for containers other than SDI</li> </ul> |

### 4 Acronyms

|             |                                      |
|-------------|--------------------------------------|
| <b>AVC</b>  | Advanced Video Coding                |
| <b>ES</b>   | Elementary Stream                    |
| <b>GOP</b>  | Group of Pictures                    |
| <b>HEVC</b> | High Efficiency Video Coding         |
| <b>MISB</b> | Motion Imagery Standards Board       |
| <b>MISP</b> | Motion Imagery Standards Profile     |
| <b>PES</b>  | Packetized Elementary Stream         |
| <b>SDI</b>  | Serial Digital Interface             |
| <b>SEI</b>  | Supplemental Enhancement Information |
| <b>ST</b>   | Standard                             |
| <b>UUID</b> | Universally Unique Identifier        |
| <b>VANC</b> | Vertical Ancillary Data Space        |

### 5 Timestamp Types

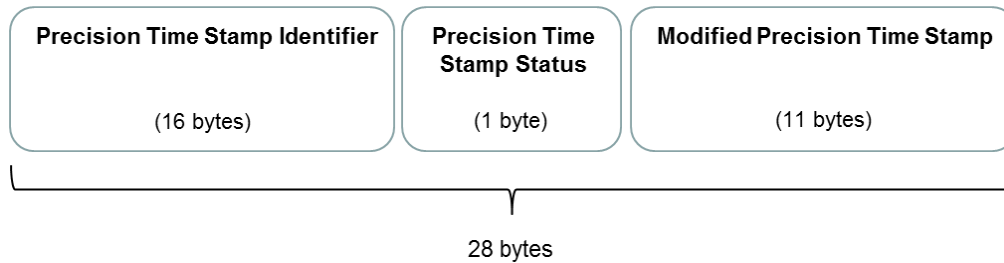
Timestamps, when applied to both Motion Imagery and metadata provide a means for correlating the events of both data types in time. MISB ST 0603 [1] defines the Precision Time Stamp, which is a sampling of the MISP Time System and represents a count of microseconds since the epoch of 1970-01-01T00:00:00.0Z – not including leap seconds – based on the International System (SI) second. Thus, the Precision Time Stamp represents a measure of absolute time.

ST 0603 also defines a Commercial Time Stamp, which is essentially time code widely used in the commercial broadcast industry for content processing/editing. Although a non-persistent, relative time indicator within a sequence of Motion Imagery, the Commercial Time Stamp can be derived from an absolute time reference; such conversions are found in SMPTE EG 40 [2].

#### 5.1 Precision Time Stamp Construct

The approved Motion Imagery compression standards for Class 1 and Class 2 Motion Imagery allocate fields for user-defined data. The Precision Time Stamp is encoded as a construct of the following three elements, shown in Figure 1, within this user-defined data field:

1. A Precision Time Stamp Identifier (16 bytes),
2. A Precision Time Stamp Status (1 byte), and
3. A Modified Precision Time Stamp (11 bytes).



**Figure 1: Elements Encoded into Class 1/Class 2 Motion Imagery**

### 5.1.1 Precision Time Stamp Identifier

The Precision Time Stamp Identifier signals the presence of the Precision Time Stamp when parsing the user-defined data field. Past use of this identifier in MPEG-2 and H.264/AVC assigned the identifier as an ASCII string “MISPMicrosecond”; however, H.264/AVC defines the field used for this information to be a UUID, which this string is not. To maintain compatibility for past uses of MPEG-2 and H.264/AVC coding the MISPMicrosecond string is continued. For H.265/HEVC and future codecs, however, a UUID is assigned instead. Sections 6.2.1, 6.3.1 and 6.4.1 define the Precision Time Stamp Identifier for the various allowed compression types.

### 5.1.2 Precision Time Stamp Status

The Precision Time Stamp Status is a one-byte value which precedes the Precision Time Stamp. It provides information regarding the reference source for the Precision Time Stamp. Refer to MISB ST 0603 for the details on the Precision Time Stamp Status.

### 5.1.3 Modified Precision Time Stamp

The Precision Time Stamp is an 8-byte, unsigned integer value, as defined in MISB ST 0603. For encoding within Class 1/Class 2 Motion Imagery, this 8-byte value is modified to prevent false interpretation of the data by a decoder; the practice is known as Start Code Emulation Prevention. The modified 8-byte Precision Time Stamp contains successive two-byte values spaced by a 0xFF value, thus forming an 11-byte Modified Precision Time Stamp value.

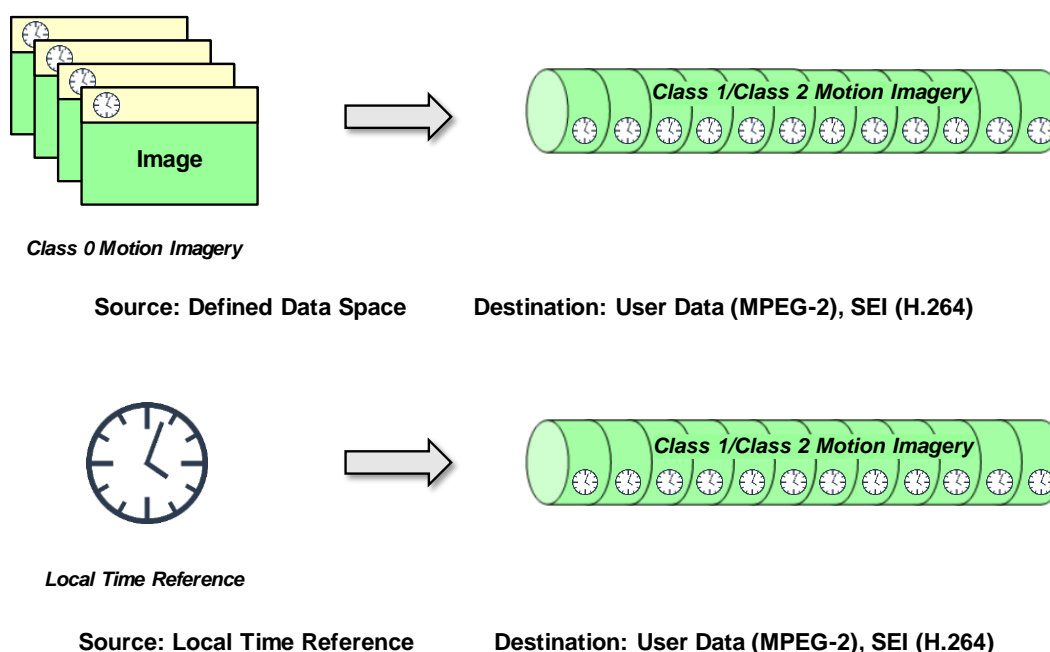
Table 1 shows the byte assignment for the one-byte Precision Time Stamp Status (Byte 17, which follows the Precision Time Stamp Indicator), and the 11-byte (Bytes 18-28) Modified Precision Time Stamp, where Byte 18 is the most significant byte of the Precision Time Stamp. The Precision Time Stamp Status plus the Modified Precision Time Stamp collectively form twelve bytes of data. Along with the 16-byte Precision Time Stamp Indicator, 28 bytes of data are then inserted into the Motion Imagery user-defined data field of the respective compressed data.

**Table 1: Byte Assignment for the Precision Time Stamp Status and the Modified Precision Time Stamp**

|              |  |                               |
|--------------|--|-------------------------------|
| Byte 17      | Precision Time Stamp Status (see MISB ST 0603 [1])             |                               |
| Bytes 18, 19 | Byte 1 and 2 (Most significant bytes) of Precision Time Stamp  | Modified Precision Time Stamp |
| Byte 20      | <i>Start Code Emulation Prevention Byte (0xFF)</i>             |                               |
| Bytes 21,22  | Byte 3 and 4 of Time Stamp                                     |                               |
| Byte 23      | <i>Start Code Emulation Prevention Byte (0xFF)</i>             |                               |
| Bytes 24, 25 | Byte 5 and 6 of Time Stamp                                     |                               |
| Byte 26      | <i>Start Code Emulation Prevention Byte (0xFF)</i>             |                               |
| Byte 27, 28  | Byte 7 and 8 (Least significant bytes) of Precision Time Stamp |                               |

### 5.1.4 Precision Time Stamp Sources

A Precision Time Stamp can originate from several possible sources as shown in Figure 2: 1) a Defined Data Space, which is allocated within a Class 0 Motion Imagery frame available for non-image data (e.g. VANC in SMPTE SDI, chunk data space in GigE Vision, or other); or 2) generated by a local time reference. The mapping of the Precision Time Stamp Identifier, Precision Time Stamp Status and Modified Precision Time Stamp to various Class 1/Class 2 Motion Imagery types is described in Section 6.

**Figure 2: Sources of the Precision Time Stamp**

MISB ST 0605 [3] provides information on the placement and encoding of the Precision Time Stamp for various Class 0 Motion Imagery containers. The following requirements apply to the reference used for the Precision Time Stamp:

| Requirement(s) |  |
|----------------|--|
| ST 0604.5-16   | When Class 0 Motion Imagery contains a Precision Time Stamp, the Precision Time Stamp shall be extracted and used as the Precision Time Stamp in the corresponding compressed Class 1/Class 2 Motion Imagery.                                  |
| ST 0604.3-03   | If Class 0 Motion Imagery does not contain a Precision Time Stamp and an absolute time reference is available, then that time reference shall be used to generate the Precision Time Stamp for the compressed Class 1/ Class 2 Motion Imagery. |

## 5.2 Commercial Time Stamp

The Commercial Time Stamp can originate from several sources: 1) the Defined Data Space (e.g. VANC in SMPTE SDI, chunk data space in GigE Vision) available for non-image data within Class 0 Motion Imagery [3]; 2) generated by a local clock reference; or 3) generated in a downstream process (such as a ground station). The Commercial Time Stamp is expressed as HH:MM:SS:FF (hours, minutes, seconds, frames; see MISB ST 0603).

The following requirement applies to the reference used for the Commercial Time Stamp:

| Requirement  |   |
|--------------|---|
| ST 0604.5-17 | Where Class 0 Motion Imagery contains a Commercial Time Stamp, the Commercial Time Stamp shall be extracted and used as the Commercial Time Stamp in the corresponding compressed Class 1/Class 2 Motion Imagery. |

## 6 Inserting Timestamps into Class 1/Class 2 Motion Imagery

The MISP-approved Motion Imagery compression standards for Class 1 and/or Class 2 Motion Imagery, and their specific requirements for timestamp inclusion are specified in this section.

### 6.1 Common Requirements

| Requirement  |  |
|--------------|--|
| ST 0604.3-07 | A Precision Time Stamp as defined in MISB ST 0603 shall be inserted in every Motion Imagery frame. |

### 6.2 MPEG-2 Compressed Elementary Stream

#### 6.2.1 Precision Time Stamp Information

The Precision Time Stamp Identifier for MPEG 2 represents the ASCII string “MISPmicrosectime”. This identifier, which precedes the Precision Time Stamp, signals the presence of the Precision Time Stamp when parsing the user-defined data field. The mapping of this ASCII string to its byte equivalent is given in Table 2.

**Table 2: Byte Equivalent for ASCII String “MISPMicrosecond”**

| Byte 1 | Byte 2  | Byte 3  | Byte 4  | Byte 5  | Byte 6  | Byte 7  | Byte 8  |
|--------|---------|---------|---------|---------|---------|---------|---------|
| M      | I       | S       | P       | m       | i       | c       | r       |
| 0x4D   | 0x49    | 0x53    | 0x50    | 0x6D    | 0x69    | 0x63    | 0x72    |
| Byte 9 | Byte 10 | Byte 11 | Byte 12 | Byte 13 | Byte 14 | Byte 15 | Byte 16 |
| o      | s       | e       | c       | t       | i       | m       | e       |
| 0x6F   | 0x73    | 0x65    | 0x63    | 0x74    | 0x69    | 0x6D    | 0x65    |

MPEG-2 (ISO 13818-2 [4]) allocates a user\_data field for user defined data. The 16-byte Precision Time Stamp Identifier, the one-byte Precision Time Stamp Status and the 11-byte Modified Precision Time Stamp form 28 bytes that are inserted into the user\_data field located between the picture header and the picture data, so that it relates to a specific frame of Motion Imagery.

| Requirement(s) |   |
|----------------|---|
| ST 0604.5-18   | A Precision Time Stamp Identifier, equal to the ASCII string “MISPMicrosecond,” shall be inserted into the MPEG-2 user_data field located between the picture header and the picture data.  |
| ST 0604.5-19   | A one-byte Precision Time Stamp Status followed by an 11-byte Modified Precision Time Stamp shall be inserted into the MPEG-2 user_data field after the Precision Time Stamp Identifier, so that it relates to a specific Motion Imagery frame. |

## 6.2.2 Commercial Time Stamp Information

MPEG-2 (ISO/IEC 13818-2 [4]) includes a 25-bit field time code (time\_code) within the “group of pictures” (GOP) header. The Commercial Time Stamp is mapped into the time\_code field as time\_code\_hours (5 bits, 0-23), time\_code\_minutes (6 bits, 0-59), time\_code\_seconds (6 bits, 0-59), and time\_code\_pictures (6 bits, 0-59). A drop\_frame\_flag and marker\_bit complete the bit assignment.

| Requirement  |  |
|--------------|--|
| ST 0604.3-09 | Where a Commercial Time Stamp is available, it shall be inserted into every Group-of-Pictures (GOP) of MPEG-2 compressed data. |

## 6.3 H.264/AVC Compressed Elementary Stream

### 6.3.1 Precision Time Stamp Information

The Precision Time Stamp Identifier for H.264/AVC represents the ASCII string “MISPMicrosecond”. This identifier, which precedes the Precision Time Stamp, signals the presence of the Precision Time Stamp when parsing the user-defined data field. The mapping of this ASCII string to its byte equivalent is given in Table 2.

H.264/AVC (ISO/IEC 14496 [5]) provides a Supplemental Enhancement Information (SEI) message – designated the user\_data\_unregistered SEI message field. The user\_data\_unregistered SEI message consists of two subfields: the uuid\_iso\_iec\_11578, which is a 16-byte UUID, and the user\_data\_payload\_byte, which is a variable length field. The uuid\_iso\_iec\_11578 is set to the 16-byte Precision Time Stamp Identifier (Bytes 1-16 of Table 2). As previously noted, this string is not a valid UUID; however, to maintain compatibility with prior use this practice is continued. The user\_data\_payload\_byte is set to the 12-byte combination Precision Time Stamp Status and Modified Precision Time Stamp (Bytes 17-28 of Table 1 with Byte 17 transmitted first).

| Requirement(s) |   |
|----------------|---|
| ST 0604.4-10   | A Precision Time Stamp Identifier, equal to the ASCII string “MISPmicrosectime,” shall be inserted into the H.264/AVC compressed user_data_unregistered SEI message field uuid_iso_iec_11578, so that it relates to a specific Motion Imagery frame. <i>Note: although similar in intent there is a non-editorial change in requirement ST 0604.4-10 from ST 0604.3-10, which was deprecated.</i> |
| ST 0604.4-12   | A one-byte Precision Time Stamp Status followed by an 11-byte Modified Precision Time Stamp shall be inserted into the H.264/AVC compressed user_data_unregistered SEI message field user_data_payload_byte, so that it relates to a specific Motion Imagery frame.   |

### 6.3.2 Commercial Time Stamp Information

H.264/AVC provides for time code in the picture timing SEI message. The picture timing SEI message (pic\_timing) specifies hours\_value (5 bits, 0-23), minutes\_value (6 bits, 0-59), seconds\_value (6 bits, 0-59) and n\_frames (9 bits) for mapping a Commercial Time Stamp (see [5]). Other flags within the pic\_timing field indicate the time of frame capture, drop-frame, and a discontinuity in the video time line.

| Requirement  |  |
|--------------|--|
| ST 0604.3-11 | Where a Commercial Time Stamp is available, it shall be inserted into the H.264/AVC pic_timing SEI message in every Class 1/ Class 2 Motion Imagery frame. |

## 6.4 H.265/HEVC Compressed Elementary Stream

### 6.4.1 Precision Time Stamp Information

The Precision Time Stamp Identifier for H.265/HEVC is the following UUID<sup>1</sup>:

a8687dd4-d759-3758-a5ce-f0338b6545f1

This Precision Time Stamp Identifier, which precedes the Precision Time Stamp, signals the presence of the Precision Time Stamp when parsing the user-defined data field.

<sup>1</sup> UUID generated from the string “MISPmicrosectime-v2” as a version 3 UUID

H.265/HEVC (ISO/IEC 23008-2 [6]) provides a Supplemental Enhancement Information (SEI) message – designated the user\_data\_unregistered SEI message field. The user\_data\_unregistered message consists of two subfields: the uuid\_iso\_iec\_11578, which is a 16-byte field UUID, and the user\_data\_payload\_byte, which is a variable length field. The uuid\_iso\_iec\_11578 is set to the 16-byte UUID given above, which is the Precision Time Stamp Identifier for H.265/HEVC. The user\_data\_payload\_byte is set to the 12-byte combination Precision Time Stamp Status and Modified Precision Time Stamp (Bytes 17-28 of Table 1 with Byte 17 transmitted first).

| Requirement(s) |  |
|----------------|--|
| ST 0604.4-13   | A Precision Time Stamp Identifier, equal to the UUID a8687dd4-d759-3758-a5ce-f0338b6545f1, shall be inserted into the H.265/HEVC compressed user_data_unregistered SEI message field uuid_iso_iec_11578, so that it relates to a specific Motion Imagery frame.      |
| ST 0604.4-14   | A one-byte Precision Time Stamp Status followed by an 11-byte Modified Precision Time Stamp shall be inserted into the H.265/HEVC compressed user_data_unregistered SEI message field user_data_payload_byte, so that it relates to a specific Motion Imagery frame. |

#### 6.4.2 Commercial Time Stamp Information

H.265/HEVC provides for time code in the time code SEI message. The time code SEI message (time\_code) specifies hours\_value (5 bits, 0-23), minutes\_value (6 bits, 0-59), seconds\_value (6 bits, 0-59) and n\_frames (9 bits) for mapping a Commercial Time Stamp (see [6]). Other flags within the time\_code field indicate the time of frame capture, drop-frame, and a discontinuity in the video time line.

| Requirement  |   |
|--------------|---|
| ST 0604.4-15 | Where a Commercial Time Stamp is available, it shall be inserted into the H.265/HEVC time_code SEI message in every Class 1/Class 2 Motion Imagery frame. |

## 7 Deprecated Requirements

| Requirement(s)               |   |
|------------------------------|---|
| ST 0604.3-02<br>(Deprecated) | If an uncompressed motion imagery signal does not contain a Precision Time Stamp, but contains a Commercial Time Stamp in the VANC (Vertical Ancillary Data Space) (MISB ST 0605 [3]), the Commercial shall be extracted from the VANC and used to calculate the Precision Time Stamp in the compressed motion imagery. |



## ST 0604.5 Timestamps for Class 1/Class 2 Motion Imagery

|                              |  |
|------------------------------|--|
| ST 0604.3-04<br>(Deprecated) | When Class 0 Motion Imagery contains a Precision Time Stamp in the VANC (Vertical Ancillary Data Space) (MISB ST 0605 [3]), the Precision Time Stamp shall be extracted from the VANC and used to calculate the Commercial Time Stamp in the corresponding compressed Class 1/Class 2 Motion Imagery.          |
| ST 0604.3-06<br>(Deprecated) | If Class 0 Motion Imagery does not contain either a Precision Time Stamp or a Commercial Time Stamp and a UTC time reference is available, then that time reference shall be used to generate a Commercial Time Stamp.   |
| ST 0604.3-10<br>(Deprecated) | A Precision Time Stamp consisting of Time Stamp Identifier, a Time Stamp Status and a start-code emulation-modified Precision Time Stamp shall be inserted into the H.264 elementary stream user data unregistered SEI Message field <code>uuid_iso_iec_11578</code> , so that it relates to a specific frame. |
| ST 0604.3-01<br>(Deprecated) | When Class 0 Motion Imagery contains a Precision Time Stamp in the VANC (Vertical Ancillary Data Space) (MISB ST 0605 [3]), the Precision Time Stamp shall be extracted from the VANC and used as the Precision Time Stamp in the corresponding compressed Class 1/Class 2 Motion Imagery.                     |
| ST 0604.3-05<br>(Deprecated) | If Class 0 Motion Imagery contains a Commercial Time Stamp in the VANC (Vertical Ancillary Data Space) (MISB ST 0605 [3]), the Commercial Time Stamp shall be extracted from the VANC and used as the Commercial Time Stamp in the corresponding compressed Class 1/Class 2 Motion Imagery.                    |
| ST 0604.3-08<br>(Deprecated) | A Precision Time Stamp Identifier, equal to the ASCII string "MISPmicrosectime", a Precision Time Stamp Status and a Modified Precision Time Stamp shall be inserted into the MPEG-2 <code>user_data</code> field located between the picture header and the picture data – in order.                          |